Automatic Air Collision Avoidance System

Auto-ACAS

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Overview

Auto-ACAS Provides the "Avoidance" for See and Avoid

- **A Common Architecture for UAVs & Piloted Aircraft**
- **Industry Advancement**
  - Address UAV Equivalency for See & Avoid in U.S. Airspace
  - Imbedded Flight Rules for Avoidance Onus
  - Enable UAV Swarming (Multiple UAVs in Close Proximity)
  - Prevent Midair Mishaps in Piloted Aircraft (*JAS-39 Grippen*)
- **Architecture**
  - Algorithm
    - **Collision Prediction**
    - **Best Escape Determination**
  - Sensor Integration
    - **Cooperative – Datalink/Transponder**
    - **Non-Cooperative – Optical/IR**
    - **Fusion**

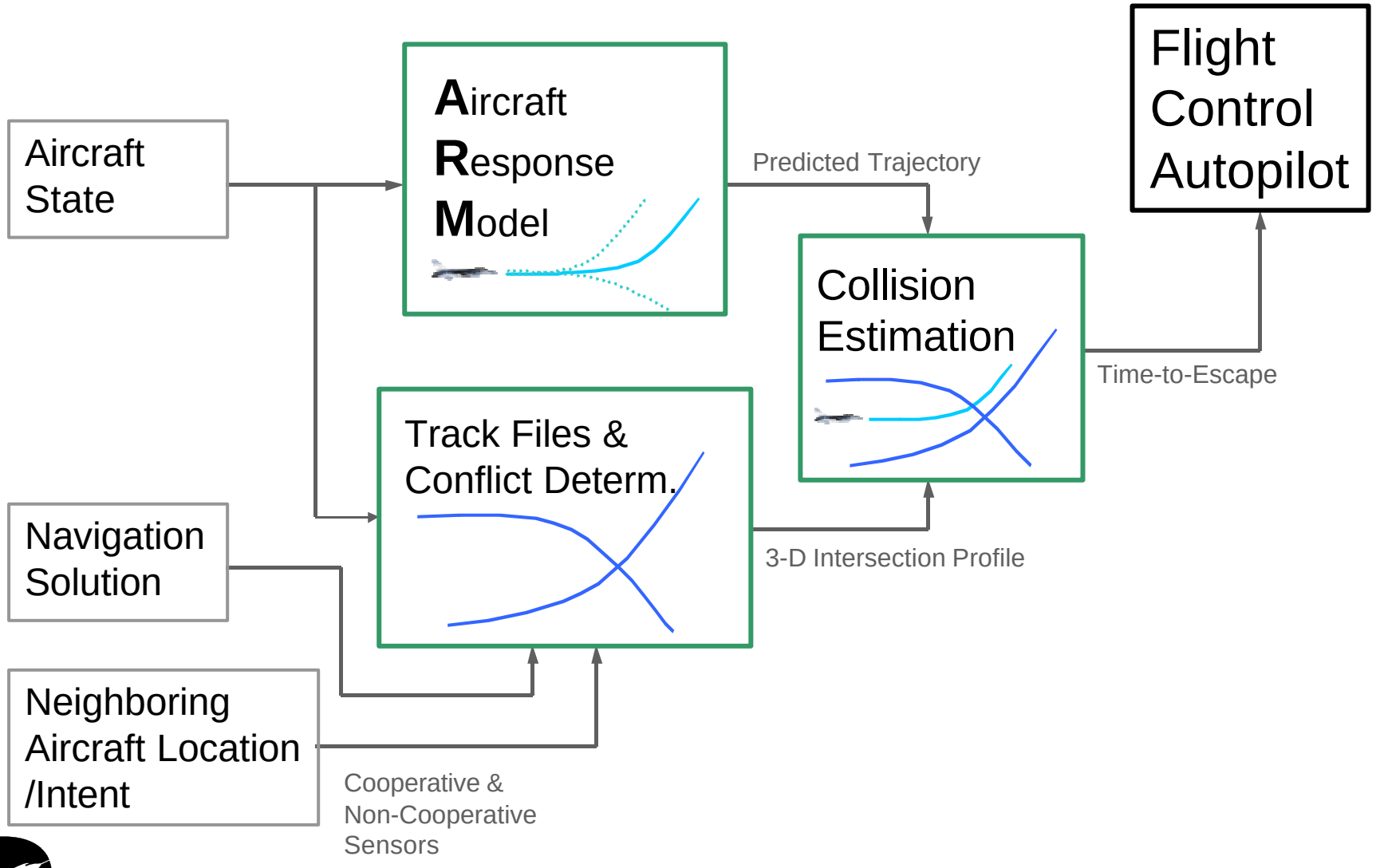
Goals & Objectives

- **Goals**
  - Allow Safe Operation of Multiple UAVs and Manned Aircraft in Close Proximity
  - Military Application with Commercial Sector Potential
  - Define a Design Process/System Architecture
    - **Broad Application**
    - **Ease Adaptation to Any Platform**
  - Independent from TCAS
    - **Initiates with feet/seconds of separation not miles/minutes**
    - **Higher level of redundancy than TCAS**
- **Objectives**
  - Develop and Demonstrate a “Nuisance Free” System
  - Demonstrate Collision Avoidance

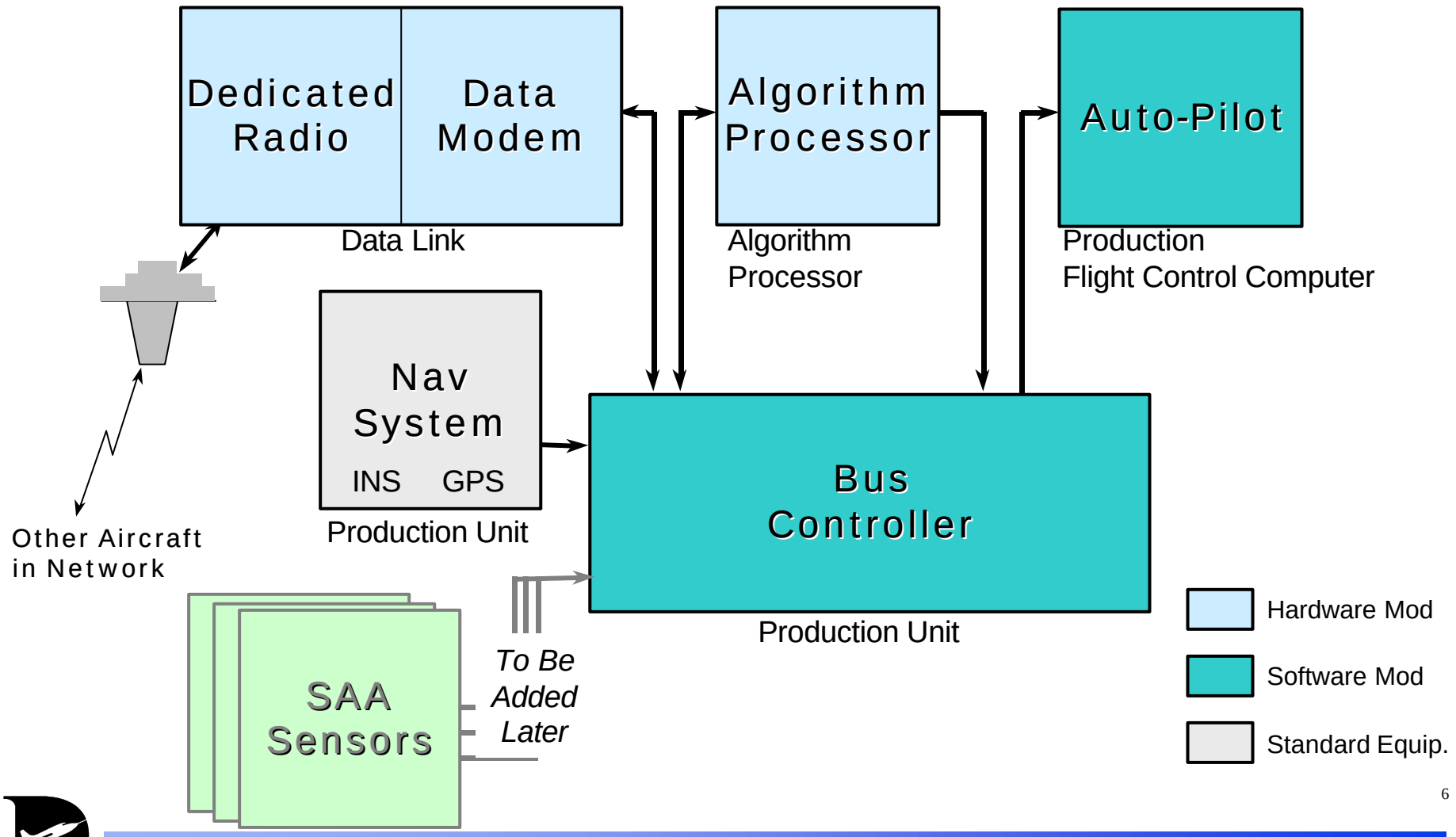
Auto-ACAS Design

- **Algorithm for Avoidance Decision**
  - Predicts Recovery Flight Path
  - Evaluates Other Neighboring Aircraft Flight Paths
  - Determines Minimum Approach of “Best Escape” Maneuver
- **Auto-Pilot Executing Avoidance Maneuver**
  - Aggressive Maneuver Relative to Aircraft Limits
    - **Roll to Best Escape Bank Angle**
    - **Pull to 5g/*AOA-limits***
  - Disengage As Soon As Flight Paths De-Conflict
- **Technology Heritage**
  - Automatic Ground Collision Avoidance (Auto-GCAS)
  - Sensor Fusion/System Wide Integrity Management
  - Aircraft Response Model
  - Auto-Pilot Architecture
  - Lower Technical Risk

Auto-ACAS
Algorithm Architecture

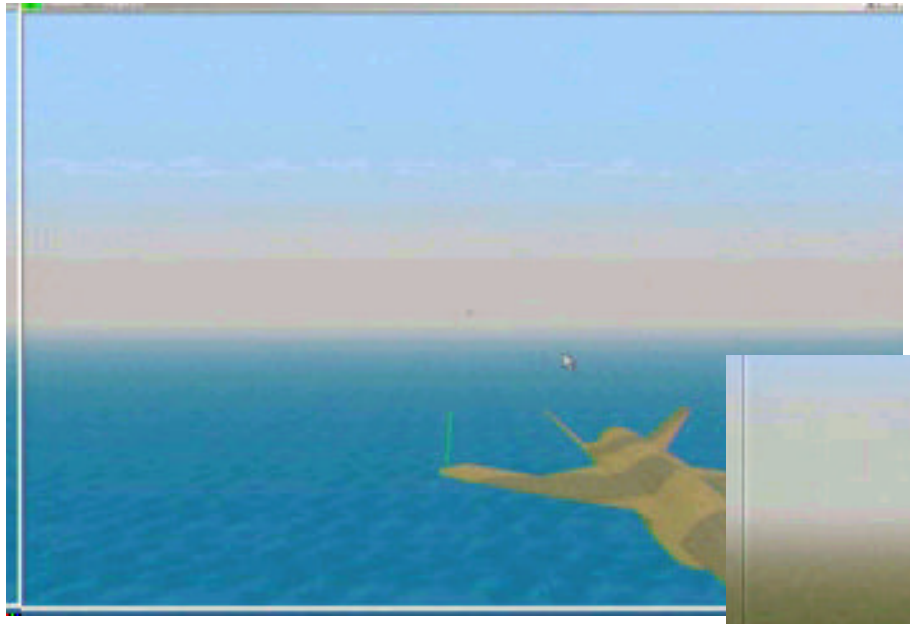


Auto-ACAS
System Block Diagram

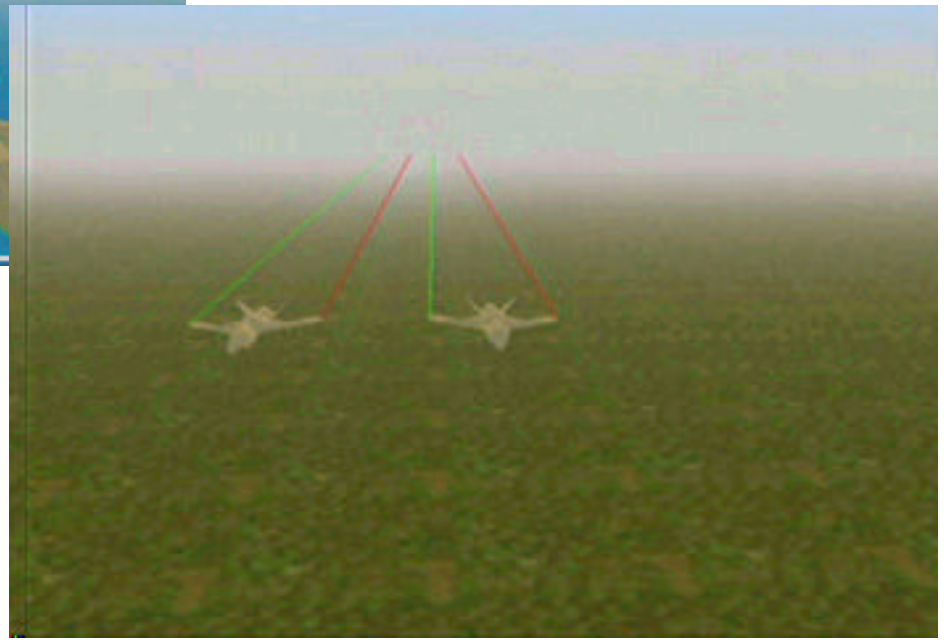


Auto-ACAS Operation

Overtaking Opponent



Scissors Maneuver



Heritage

Auto-GCAS History

- **Flight Tes**
  - Began in
  - Over 22C Flight
  - Over 70C Recoveri
  - 30+ Eval
  - Most Lik the *AFTI*

Project Description
Program Plan

- **Phase 1** (May 00 to Mar 01)
  - Concept Study
- **Phase 2** (3Qtr FY01 to 4Qtr FY03)
  - Focus on Vehicle Control not Sensors
    - **Data Link is Primary Sensor**
  - Develop & Flight Demonstrate Technology
    - **2 Piloted Fighter Aircraft**
    - **Flight Demonstration of Minimum Clearance Penetration Prevention**
    - **Buildup for Unmanned Testing**
    - **Demonstrate UAV Avoidance of Manned Aircraft**
  - Identify Sensor & System Requirements
- **Follow-On Phase : Full Integration**
  - UAV/ROA Flight Test
  - See-and-Avoid Sensor Integration
  - Auto Ground Collision Avoidance Integration

Questions?